PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. ______

Project No. E-21-693 (R6030-0A0) GTRC/~~GIT~~ DATE 9 /18 /85

Project Director: Dr. M. Gamal Moharam School/~~Lab~~ Electrical Engineering

Sponsor: Massachusetts Institute of Technology
Lincoln Laboratory

Type Agreement: Purchase Order No. CX-6640 (Under Gov't Prime F19628-85-C-002)

Award Period: From 7/1/85 To 10/15/85 (Performance) 10/15/85 (Reports)

Sponsor Amount:

	This Change	Total to Date
Estimated:	$ 35,250	$ 35,250
Funded:	$ 35,250	$ 35,250

Cost Sharing Amount: $ None Cost Sharing No: N/A

Title: Diffractive Optical Elements for Coherent Beam Addition

ADMINISTRATIVE DATA OCA Contact Brian J. Lindberg X4820

1) Sponsor Technical Contact:

Dr. Wilfrid Veldkamp
MIT-Lincoln Laboratory
P. O. Box 73
Lexington, Massachusetts 02173-0073
(617) 863-5500

2) Sponsor Admin/Contractual Matters:

Nancy J. Alusow
Associate Purchasing Manager
MIT-Lincoln Laboratory
P. O. Box 73
Lexington, Massachusetts 02173-0073
(617) 863-5500 X7134

Defense Priority Rating: DO-A7

Military Security Classification: N/A
(or) Company/Industrial Proprietary: N/A

RESTRICTIONS

See Attached N/A Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with none proposed or anticipated.

COMMENTS:

SEP 1985
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Project Director	Procurement/GTRI Supply Services	GTRC
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Accounting	Research Communications (2)	Other Jones

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 1/21/86

Project No. E-21-693 (R6030-0A0) School/XXX Electrical Engineerin

Includes Subproject No.(s)

Project Director(s) Dr. M. Gamal Moharam GTRC / XXX

Sponsor Massachusetts Institute of Technology-Lincoln Laboratory

Title Diffractive Optical Elements for Coherent Beam Addition

Effective Completion Date: 10/15/85 (Performance) 10/15/85 (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [X] Final Invoice or Final Fiscal Report
- [ ] Closing Documents
- [X] Final Report of Inventions
- [X] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other

Continues Project No. Continued by Project No.

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Other A. Jones; M. Heyser; R. Embr

FORM OCA 69.285

E-21-693

GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF ELECTRICAL ENGINEERING
ATLANTA, GEORGIA 30332

TELEPHONE: (404) 894-2961

January 9, 1986

Massachusetts Institute of Technology
Lincoln Laboratory Distribution Office
Lexington, Massachusetts 02173-0073

To Whom it May Concern:

Attached please find a Fiscal Status Report for the period July 1 - October 15, 1985 for your Purchase Order No. CX-6640 (Under Government Prime F19628-85-C-002). We apologize for the delay on this report, but although the effective date of this project was July 1, 1985, we did not receive the signed contract from MIT until September, 1985.

Should you have any questions concerning the report, please do not hesitate to contact me at 404/894-2961.

Sincerely,

Cindy Meyer
Administrative Assistant

CM
Attachment

cc: Dr. Wilfrid Veldkamp
MIT-Lincoln Laboratory

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FISCAL STATUS REPORT
Purchase Order No. CX-6640
Under Government Prime F19628-85-C-002

Massachusetts Institute of Technology
Lincoln Laboratory

Project Director: Dr. M. Gamal Moharam
School of Electrical Engineering
Georgia Institute of Technology

July 1 - October 15, 1985

1. Engineering man hours expended during report period: 348 hours

2. Total man hours expended during report period: 609 hours

3. Funds expended during report period and total to date: $20,120

4. Statement whether or not it is anticipated that contract will be completed within the contract total commitment:

The project was completed within the original time frame of the project.

FINAL REPORT

DIFFRACTIVE OPTICAL ELEMENTS
FOR COHERENT BEAM ADDITION

Submitted to

MIT LINCOLN LABORATORY
Lexington, Massachusetts 02173-0073

Attention: Dr. Wilfrid B. Veldkamp

by

School of Electrical Engineering
Georgia Institute of Technology
Atlanta, Georgia 30332

(Professor M. G. Moharam)

November 1985

ABSTRACT

The purpose of this work is to develop a better understanding of the diffraction characteristics of the diffractive optical elements used as multiplexing elements in proposed schemes for coherent beam additions in the infrared region of the spectrum. Significant progress has been made in investigating the appropriate configurations of the diffractive optical elements for various beam addition schemes. A new analytical model needed to study the diffraction characteristics of one such binary metallic grating elements has been developed.

STATEMENT OF WORK

The purpose of this work is to a develop better understanding of the diffraction characteristics of the diffractive optical elements used as multiplexing elements in proposed schemes for coherent beam additions in the infrared region of the spectrum. Significant progress has been made in the short duration of the project. The appropriate configurations of the diffractive optical elements for various beam addition schemes are investigated. The analytical tools needed to study the diffraction characteristics of such multiplexing elements are explored and a new analytical model to analyze one such element is developed.

One particular scheme for coherent beam addition has been extensively investigated. In this scheme, two IR laser beams are incident symmetrically on a metallic binary grating. The grating period and the angle of incidence are such that the first diffracted order of each beam is strongly reflected in the same direction normal to the grating plane. In addition, the second diffracted order of each of the two beams is weakly reflected back into the direction of its own incident beam. As a result, the two strongly reflected (diffracted) first orders will be combined coherently. The two second order diffracted beams are not lost and will be used in the laser cavity. In this scheme, the angle of incidence is the second Bragg angle of the grating, that is, sine the angle of incidence is equal to the incident light wavelength to the grating period ratio. light wavelength.

To analyze this configuration for the binary grating element, a model has been developed to determine the diffraction characteristics of perfectly conducting binary gratings. The model is applicable to arbitrary grating (period, depth, and aspect ratio) and arbitrary incident wave (wavelength, angle of incidence, and polarization). The model is relatively simple and is easily implemented on digital computers. Execution time is very fast (less than one second per point). The model is tested by reproducing the results obtained in previous work for limiting cases. Excellent agreements are obtained. A manuscript describing the new model and the results obtained for the diffraction characteristics of general perfectly conducting binary gratings is being prepared for publication in the Journal of the Optical Society of America.

The developed model is applied to the diffractive optical element proposed in the scheme described above for coherent addition. Here the diffraction characteristics of the grating element is determined for each of the two incident beams independently. These diffracted fields are combined assuming in phase condition. It is found that the two beams can be coherently combined in the direction of the first diffracted order with the appropriate grating element configuration. Unfortunately, the intensities of the two second diffracted orders are found to be significantly larger than desired, and that may cause instability problems in the two laser cavities. The study is for both TE and TM polarizations and for several angle of incidence / grating period configurations.

It is planned to continue the work to determine whether it is possible to reduce the second order diffraction by using a different binary grating configuration. The development of a new model that allows for the finite conductivity of the metallic gratings and for more practical gratings where a metallic film is deposited on periodic dielectric substrate is also planned. The model would be more accurate if the two laser cavities are included in the analysis. The relative spatial phase shift between the two incident beams is an important factor and it will significantly affect the diffraction characteristics of the binary grating element. This phase shift will also be included in the new model. Other schemes for coherent beam addition will be explored, and the new binary grating configurations will be investigated.